**Description**

The FS1023 MEMS Liquid Flow Sensor Module measures the flow rate using the thermo-transfer (calorimetric) principle. The FS1023 is designed to measure liquids. The sensor output is amplified and trimmed at zero flow for module to module consistency.

The FS1023 offers key advantages over resistor-based flow solutions. The sensor utilizes thermopile sensing, which provides an excellent signal-to-noise ratio. The sensor comprises a “solid” thermal isolation technology and silicon-carbide coating, which protects it from abrasive wear and provides robustness and long-term reliability. In comparison, other sensors typically contain a fragile membrane above an etched cavity for the thermal isolation base.

There are no moving mechanical parts that can break in contrast to other flow meter types, such as a turbine-type meter. The FS1023 has minimal flow resistance, making it highly suitable for gravity-feed applications or for replacing a high-power pump with a lower power device.

The FS1023 is a NSF-certified component.

**Features**

- Liquid flow: 0 to 3 liters/min
- Robust “solid” isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Low-power application
- Minimal flow resistance
- Fast response: < 5ms
- Analog voltage output
- Thermistor voltage output: 1V to 4.5V
- Supply voltage: 5V
- Module operating temperature range: 0°C to +85°C

**Typical Applications**

- Beverage equipment
- Liquid-dispensing system
- Process controls and monitoring
- Fluid leak detection

FS1023 Flow Sensor Module

![FS1023 Flow Sensor Module](image)
Pin Assignments

Figure 1. Pin Assignments for Module – Top View

Pin Descriptions

Table 1. Pin Descriptions

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pad Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VDD</td>
<td>In</td>
<td>Supply voltage</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>In</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>OUTPUT</td>
<td>Out</td>
<td>Flow analog output</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>–</td>
<td>Do not connect[a]</td>
</tr>
<tr>
<td>5</td>
<td>HE</td>
<td>In</td>
<td>Heater enable, +5V</td>
</tr>
<tr>
<td>6</td>
<td>TEMP</td>
<td>Out</td>
<td>Thermistor analog output</td>
</tr>
</tbody>
</table>

[a] “NC” stands for not connected / no connection required / not bonded.
Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the FS1023 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions might affect device reliability.

Table 2.  Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{IN}} )</td>
<td>Supply Voltage</td>
<td></td>
<td></td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>( T_{\text{STOR}} )</td>
<td>Storage Temperature</td>
<td></td>
<td>0</td>
<td>105</td>
<td>°C</td>
</tr>
</tbody>
</table>

Operating Conditions

Table 3.  Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{IN}} )</td>
<td>Supply Voltage</td>
<td></td>
<td>5.0</td>
<td>5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( T_{\text{AMB}} )</td>
<td>Ambient Operating Temperature (in air)</td>
<td></td>
<td>0</td>
<td>85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>( P_{\text{CM}} )</td>
<td>Common-Mode Pressure</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>PSI</td>
</tr>
</tbody>
</table>

Electrical Characteristics

Table 4.  Electrical Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{\text{IN}} )</td>
<td>Current Consumption</td>
<td></td>
<td>10</td>
<td>15</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>( F_{\text{LQ}} )</td>
<td>Liquid Flow Range</td>
<td></td>
<td>0</td>
<td>3</td>
<td>3.5</td>
<td>Liter/min</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>Analog Voltage Output</td>
<td>At 0.5 Liter/min, 25°C (water)</td>
<td>1.66</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At 3.0 Liter/min, 25°C (water)</td>
<td>3.22</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( V_{\text{NULL}} )</td>
<td>Flow Null Voltage</td>
<td>In water, no flow</td>
<td>0</td>
<td>0.003</td>
<td>0.005</td>
<td>V</td>
</tr>
<tr>
<td>( \tau_{\text{H}} )</td>
<td>Flow Response Time[^{[a]}]</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>msec</td>
</tr>
<tr>
<td>( V_{\text{TEMP}} )</td>
<td>Temperature Output</td>
<td>At 5°C (in air)</td>
<td>4.25</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At 80°C (in air)</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

\[^{[a]}\] The flow response time includes a 10% to 90% rise time for the flow sensor to electrically respond to any liquid flow change. Measurements might be affected by the pneumatic interface.
Flow Graphs

The graph in Figure 2 shows the voltage output versus flow.

From a flow rate of 0.5 to 3.0 SLPM, the voltage output can be correlated by the following approximation:

\[
\text{Flow rate (liters/min)} = 0.2113 \times (V_{\text{out}})^2 + 0.5733 \times V_{\text{out}} - 1.0328
\]

Figure 2. Flow Output Curve
**Heater Enable**

The FS1023 allows power savings through the operation of the Heater Enable (HE) pin. The flow sensor element includes a micro-heater. The HE pin powers the micro-heater. When a measurement is taken, the HE pin must be powered on and connected to +5VDC. To conserve power, the HE pin can be pulsed on when taking measurements or grounded (turned off) when no measurements are required. Alternatively, the HE pin can be constantly powered on.

**Electrical Connector**

A 6-position receptacle (not provided) is required to mate to the board crimp style connector. A part number example is PHR-6 (JST).

![Figure 3. Receptacle Drawing](image)

**Module Material**

The wetted contact surface of the FS1023 consists of the following:

- Housing – Polyphenylene Ether (PPE) + Polystyrene (PS) blend resin
- Flow Sensor – Silicon-carbide thin film
- Epoxy
- Gasket – Silicone
- Substrate – Gold plating

**Tubing Guidance**

The FS1023 module has barb tube endings. Tubing with a nominal 3/8inch (9.5mm) internal diameter is recommended for use. A hose clamp or zip tie can be used to secure the tubing.
**Mechanical Drawings**

The package outline drawings are appended at the end of this document and are accessible from the link below. The package information is the most current data available.

https://www.idt.com/document/psc/fs1023-package-outline-drawing-580-x-315-mm-module-mod0d1

---

**Ordering Information**

<table>
<thead>
<tr>
<th>Orderable Part Number</th>
<th>Description and Package</th>
<th>Shipping Packaging</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS1023</td>
<td>FS1023: 0 to 3 liter/min liquid flow sensor module with amplified analog output</td>
<td>Box</td>
<td>0°C to +85°C</td>
</tr>
</tbody>
</table>

---

**Revision History**

<table>
<thead>
<tr>
<th>Revision Date</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 10, 2018</td>
<td>Updated specifications; added flow curve, electrical connector drawing, and module material.</td>
</tr>
<tr>
<td>December 18, 2017</td>
<td>Initial release.</td>
</tr>
</tbody>
</table>
Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.

2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

3. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.

4. Renesas Electronics products are classified according to the following two quality grades. "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

5. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.

6. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.

7. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.

8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.

10. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.

11. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

Corporate Headquarters
TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information
For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/

Trademarks
Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

(Rev.4.0-1 November 2017)

© 2019 Renesas Electronics Corporation. All rights reserved.